United States Patent [19]

Mrlik

[11] **3,936,250**

[45] **Feb. 3, 1976**

[54] **CORNER SEAL COIL SPRING ARRANGEMENT FOR ROTARY ENGINE**

[75] Inventor: **Jerry R. Mrlik,** Birmingham, Mich.

[73] Assignee: **General Motors Corporation,** Detroit, Mich.

[22] Filed: **July 10, 1974**

[21] Appl. No.: **487,173**

[52] **U.S. Cl.** **418/121;** 418/122; 418/142

[51] **Int. Cl.**[2] **F01C 19/04;** F01C 19/08; F04C 27/00

[58] **Field of Search** 418/120–123, 418/142; 123/8.01

[56] **References Cited**

UNITED STATES PATENTS

3,286,912	11/1966	Tado	418/120
3,485,217	12/1969	Irgens	418/121
3,829,252	8/1974	Nakano	418/142

FOREIGN PATENTS OR APPLICATIONS

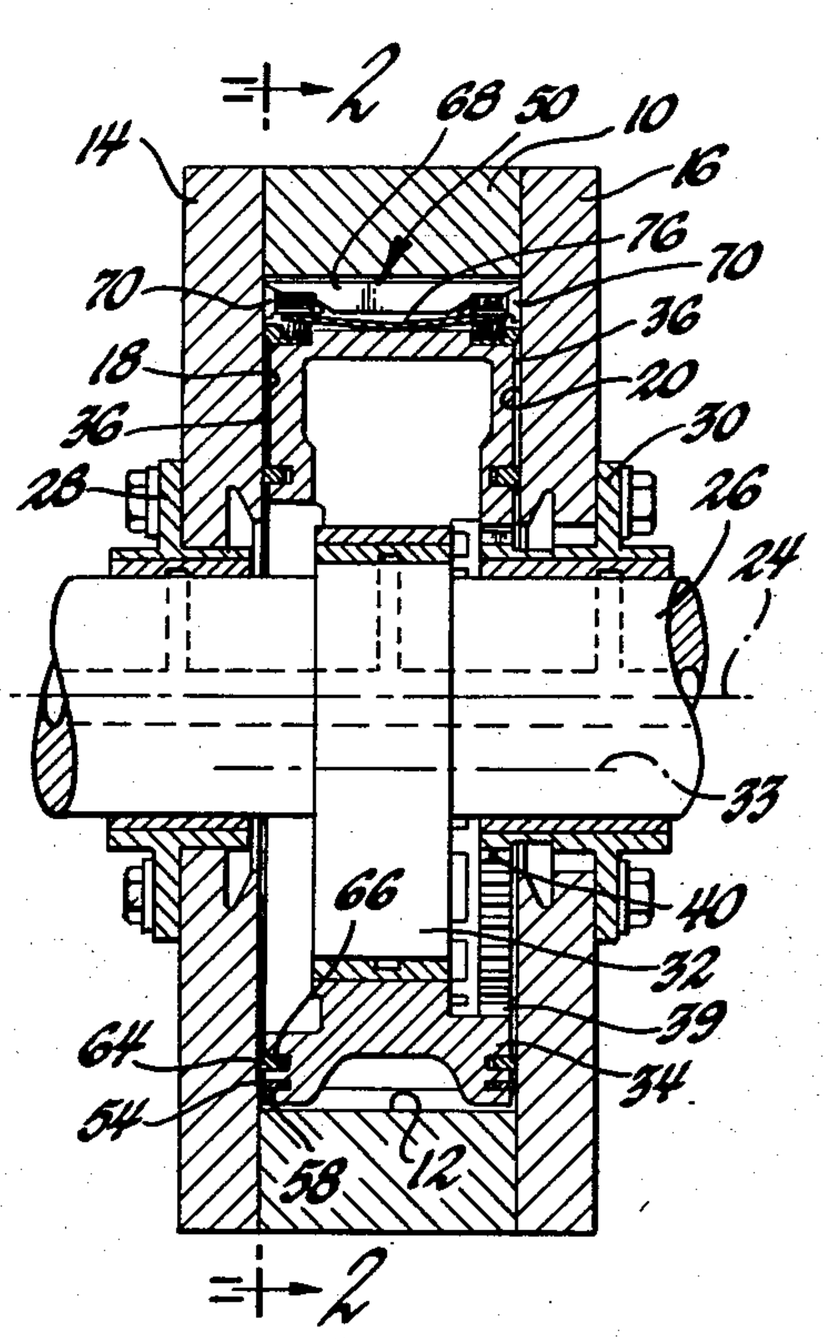
1,135,708	8/1962	Germany	418/121

Primary Examiner—John J. Vrablik
Attorney, Agent, or Firm—Ronald L. Phillips

[57] **ABSTRACT**

The corner seals and apex seals in a rotary engine are structured to permit coil springs to be concentrically arranged with and bias the corner seals.

3 Claims, 5 Drawing Figures



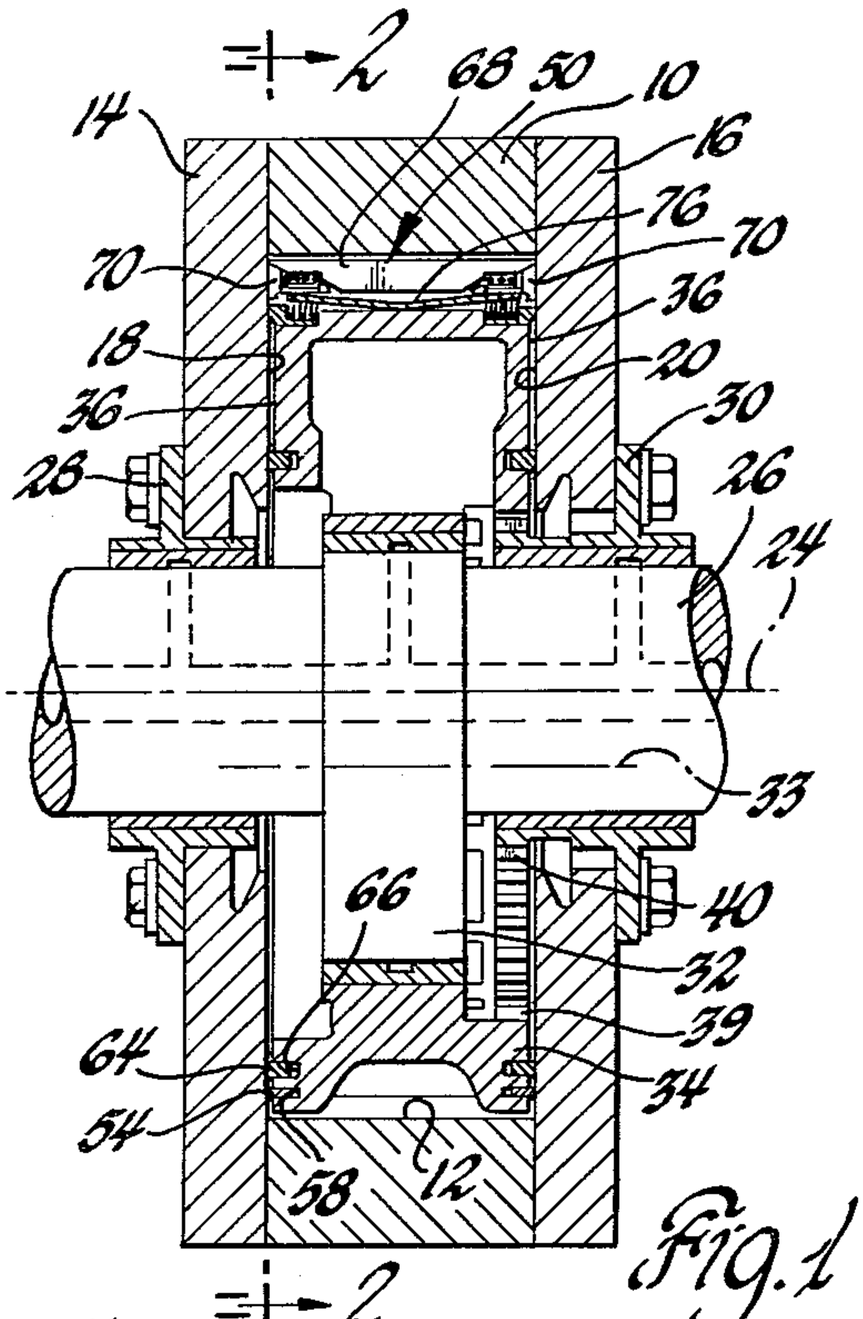


Fig. 1

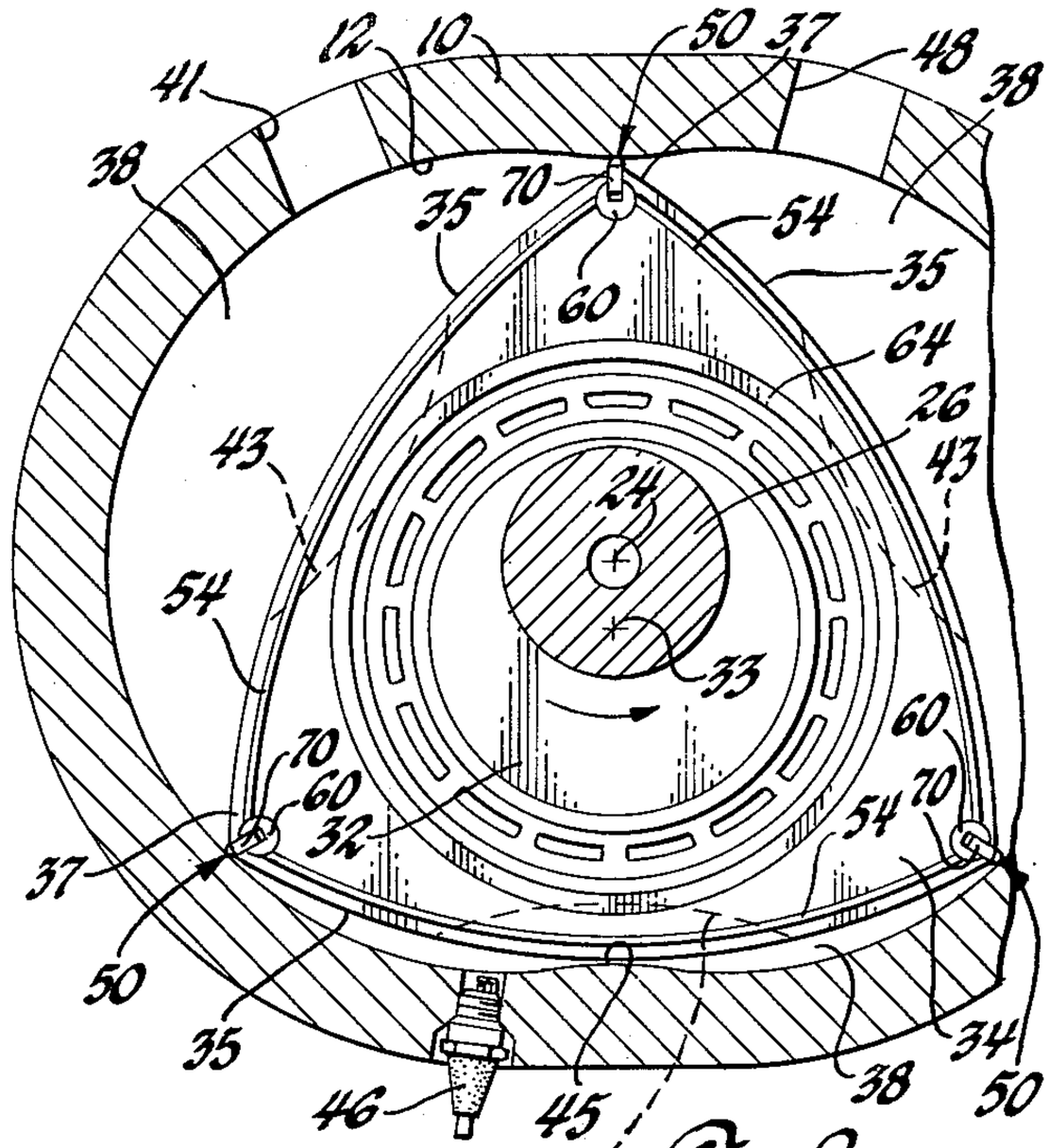


Fig. 2

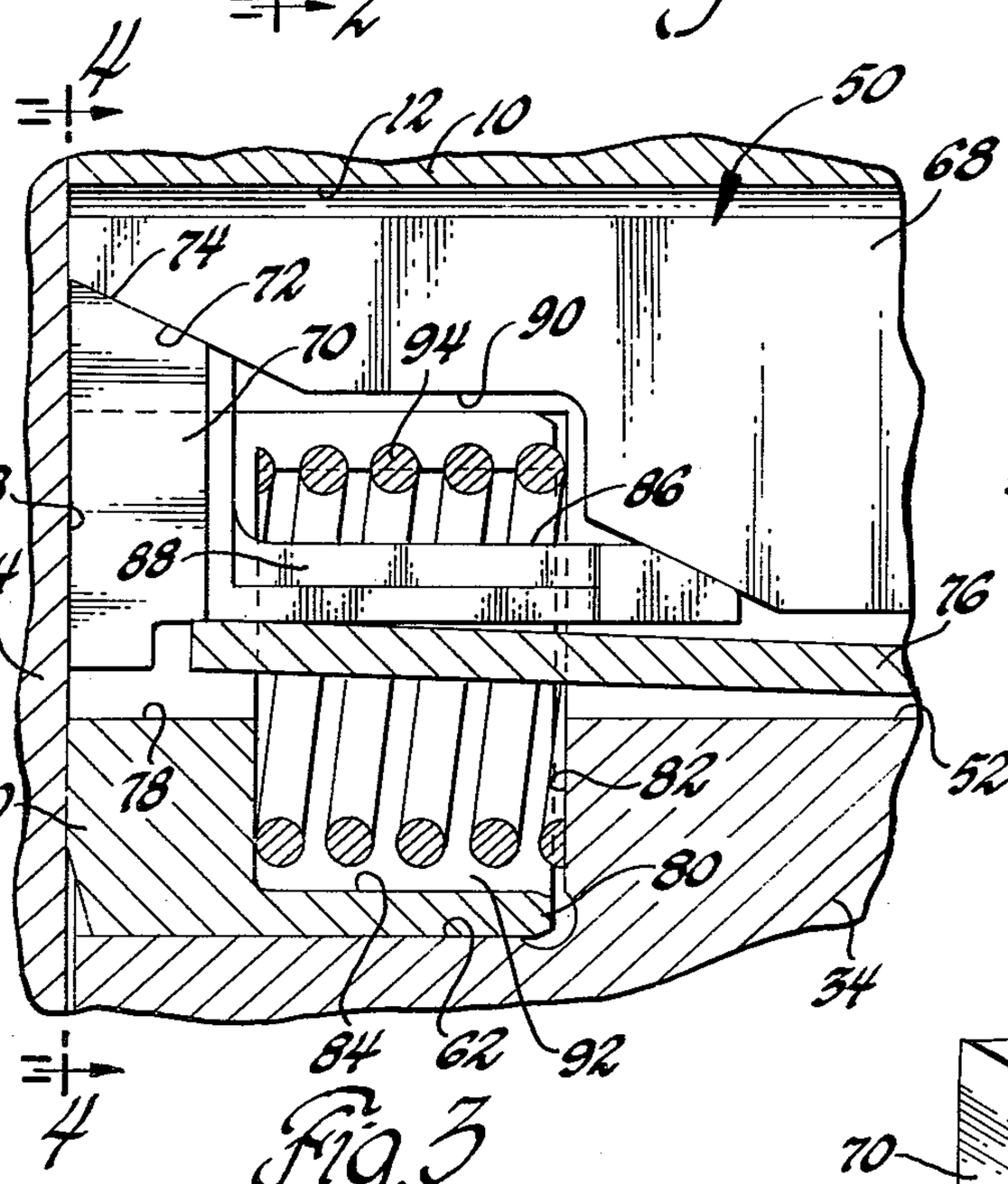


Fig. 3

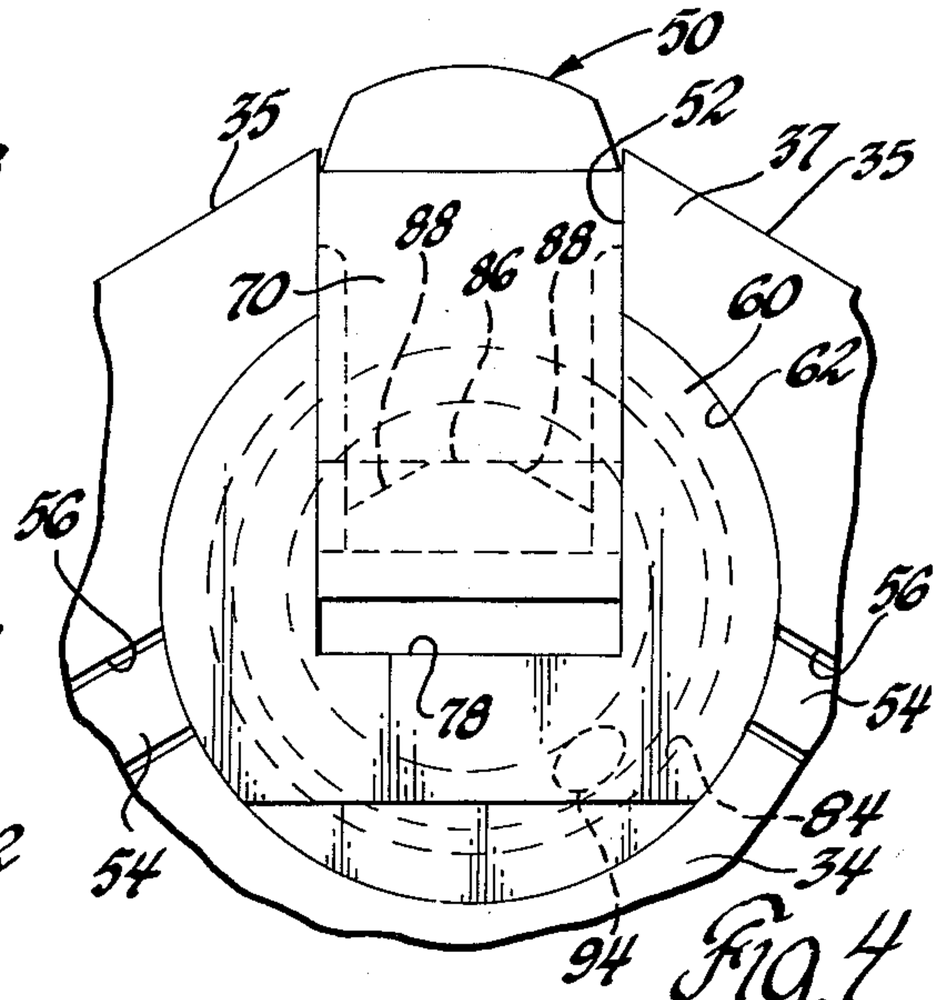


Fig. 4

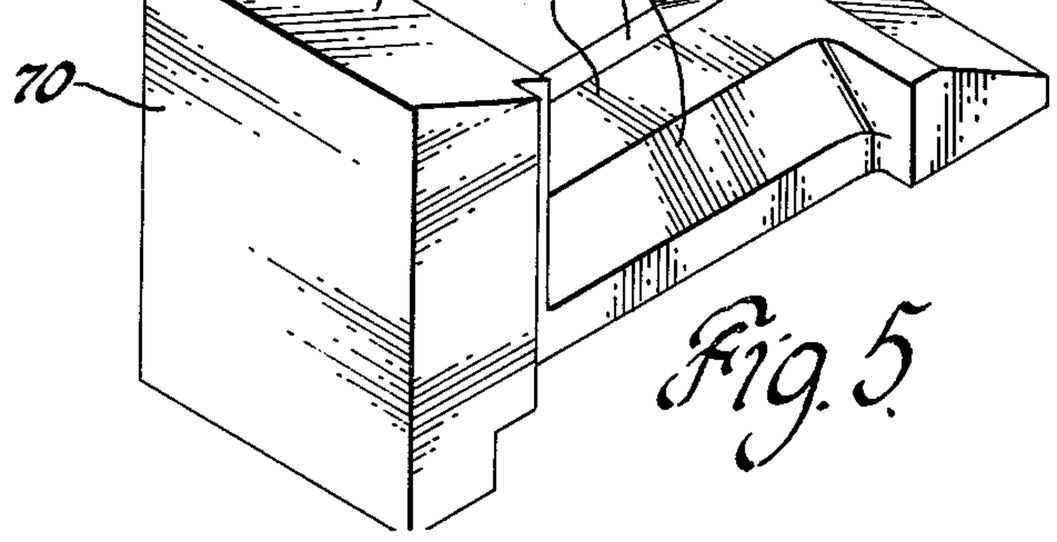


Fig. 5

CORNER SEAL COIL SPRING ARRANGEMENT FOR ROTARY ENGINE

This invention relates to a corner seal coil spring arrangement for a rotary engine and more particularly to a coil spring that is concentrically arranged with and biases the corner seals.

In current commercial rotary engines, it is common practice to have a gas sealing grid on the rotor which includes corner seals that provide sealed junctures between apex seals and side seals. In such an arrangement, the springs which bias the corner seals against the engine's stationary side walls are typically horseshoe shaped leaf or wire springs that produce unbalanced off-center loading which may bind the corner seals and, in addition, are limited to a load based on maintaining a reasonable spring rate.

An object of the present invention is to provide a new and improved corner seal coil spring arrangement for a rotary engine.

Another object is to provide a corner seal coil spring arrangement for a rotary engine that provides balanced loading on the corner seal that is not limited by a reasonable spring rate.

Another object is to provide a corner seal coil spring arrangement for a rotary engine wherein the coil spring is mounted concentric with the corner seal in a space formed by restructuring of both the corner seal and apex seal to provide balanced loading on the corner seal to avoid binding of the corner seal with such loading not limited by the maintenance of a reasonable spring rate.

These and other objects of the present invention will become more apparent from the following description and drawing in which:

FIG. **1** is an elevational view with parts in section of a rotary combustion engine having corner seal coil spring arrangements according to the present invention.

FIG. **2** is a view of the engine taken along the line **2—2** in FIG. **1.**

FIG. **3** is an enlarged view of one corner of the rotor in FIG. **1** showing one of the corner seal coil spring arrangements.

FIG. **4** is a view taken along the line **4—4** in FIG. **3.**

FIG. **5** is a perspective view of the apex seal end pieces that assist in accommodating the corner seal coil springs.

The corner seal coil spring arrangement according to the present invention is for use in rotary engines including rotary combustion engines, compressors, pumps and the like. Referring to FIG. **1,** the rotary engine may, for example, be an internal combustion engine of current production type having a stationary outer body comprising a rotor housing **10** having an inwardly facing inner peripheral wall **12** and a pair of end housings **14** and **16** having parallel, oppositely facing, spaced, inner end walls **18** and **20,** respectively. The housing parts are rigidly secured together by bolts, not shown, with the inner walls **12, 18** and **20** cooperatively providing a cavity. Referring to FIG. **2,** the peripheral wall **12** is in the shape of a two-lobe epitrochoid or a curve parallel thereto whose centerline is indicated at **24.** A crankshaft **26** extends through the cavity and is rotatably supported in bearing lined collars **28** and **30** that are bolted to the end housings **14** and **16,** respectively, as shown in FIG. **1,** the crankshaft axis being coincident

with the centerline **24,** parallel to the peripheral wall **12** and perpendicular to the end walls **18** and **20.** The crankshaft **26** is provided in the cavity with an eccentric **32** whose centerline **33** parallels the crankshaft axis **24.** A rotor **34** has a central hub having a bearing press-fitted therein which is received on the eccentric **32** whereby the rotor **34** is supported in the cavity for rotation about the eccentric's centerline **33** which is thus the rotor's axis. The rotor **34** has the general shape of a triangle with three outwardly facing convex peripheral flanks or faces **35** which face the peripheral wall **12** and parallel sides **36** which face the end walls **18** and **20.** As the rotor turns with respect to the peripheral wall **12** on the turning crankshaft **26,** each of the rotor's corners or apexes **37** remains close to the peripheral wall **12** whereby the rotor faces **35** cooperate with the wall **12** and also with the end walls **18** and **20** to define three variable volume working chambers **38** that are spaced around the rotor and move with the rotor within the housing as the rotor rotates about its axis while planetating with respect to the crankshaft axis.

With the two-lobed peripheral wall **12** and the three corner rotor **34,** each of the working chambers **38** sequentially expands and contracts between minimum and maximum volume twice during each rotor revolution in fixed relation to the housing by forcing the rotor to rotate at one-third the speed of the crankshaft. This is accomplished by gearing comprising an internal tooth gear **39** which is concentric and integral with rotor **34.** The gear **39** meshes with an external tooth gear **40** which is received with clearance about and is concentric with the crankshaft **26** and is made stationary by being formed integral with the right-hand collar **30** as shown in FIG. **1.** The gear **39** has one and one-half times the number of teeth as the gear **40** to provide the required speed ratio of 3:1 between the crankshaft and rotor.

A combustible air-fuel mixture from a suitable carburetor arrangement, not shown, is made available to the working chambers **38** as they expand through an intake port **41** in rotor housing **10** as the rotor rotates in the direction indicated by the arrow in FIG. **2.** A single channel or recess **43** is provided in the center of each chamber face of the rotor to provide for the transfer of working gases past the peripheral wall's cusp **45** when a rotor face is near its top-dead-center position, as shown in FIG. **2,** so that the chambers are not divided by the cusp **45** at the time when combustion is to occur therein. A spark plug **46** is mounted in the rotor housing **10** adjacent the cusp **45** with its electrodes exposed to the working chambers. As the rotor planetates, the working chambers successively draw in fuel mixture as the leading rotor corners pass the intake port **41.** The trailing corner of the rotor for each chamber then closes this chamber to the intake port whereafter the fuel mixture is thus trapped and then compressed and when the rotor face of this chamber is in the vicinity of top-dead-center, this mixture is ignited at the completion of the compression phase, there being provided a suitable ignition system, not shown, for providing voltage to the spark plug at the proper time. Upon ignition of the mixture in each working chamber the peripheral wall takes the reaction forcing the rotor to continue turning while the gas is expanding. The leading rotor corner of each working chamber eventually traverses an exhaust port **48** in the rotor housing as they again contact whereby the exhaust products are then expelled to complete the cycle.

Sealing of the chambers **38** for such four-cycle internal combustion engine operation is mandatory and is typically provided by three apex seals **50** which are rectangularly shaped in cross-section as shown in FIG. **4,** and are each mounted in an axially extending radially outwardly facing rectangularly shaped slot **52** that is located in each apex or corner **37** of the rotor and extends the axial width thereof as shown in FIG. **1.** Three arcuate shaped side seals **54** are mounted in accommodating axially outwardly facing grooves **56** in each rotor side and extend adjacent a rotor face between two apex seals **50** and are urged by wave springs **58** located therebehind to engage the opposing end wall. Furthermore, three cylindrically shaped corner seals **60** are each mounted in a cylindrical hole **62** in each rotor side corner with each corner seal urged to engage the opposing end wall by corner seal coil spring arrangements according to the present invention as described in more detail later and providing a sealed juncture between the adjacent ends of two side seals **54** and one apex seal **50** as shown in FIG. **4.** In addition to this gas sealing arrangement or grid there is also provided radially inward thereof a circular oil seal **64** that is mounted in an accommodating axially outwardly facing groove in each rotor side and is urged by a wave spring **66** to engage the opposing end wall.

In the gas sealing arrangement at each corner of the rotor as best shown in FIGS. **1, 3** and **4,** the apex seal **50** in this instance is a three-piece seal which is chosen for very tight sealing. The apex seal comprises a center piece **68** for engaging the peripheral wall **12** and a pair of identical end pieces **70** for engaging the opposing end walls **18** and **20.** The apex seal center piece **68** and end pieces **70** have mating ramps or inclined interfaces **72** and **74** and a leaf spring **76** which is seated at its middle on the bottom of the apex seal slot **52** engages at or near its outer ends with the bottom of the end pieces **70** to apply a radially outwardly acting force thereon. In response, the mating ramps **72** and **74** provide a wedging action that forces the center apex seal piece **68** radially outwardly against the peripheral wall **12** while the end pieces **70** are forced axially outwardly against the opposing end walls **18** and **20.** Furthermore, each of the corner seals **60** has a rectangularly shaped radially outwardly facing slot **78** which closely receives the adjoining apex seal end piece **70** to permit sliding therebetween in mutually perpendicular directions of movement on the rotor while sealing is maintained therebetween. Typically, the corner seals **60** are biased to continuously engage the respective end walls **18** and **20** by separate leaf or wire springs located between the flat C-shaped inner end **80** of the corner seals and the flat C-shaped bottom **82** of the accommodating corner seal holes **62.** These typical corner seal springs have a horseshoe shape when viewed from the front and a γ shape when viewed from the side and as a result, they effect off-center loading on the corner seal which may restrict the movement thereof, and unless restrained from turning relative to the corner seals may engage at one end with one side of the apex seal and restrict its movement. Furthermore, such springs are normally limited to applying a load on the corner seal based on maintaining a reasonable spring rate and may as a result not have a high enough spring load to overcome the frictional forces produced by carbon deposits and varnish that accummulate as a result of combustion. Such known corner seal spring designs are disclosed in U.S. Pat. No. 3,711,229.

According to the present invention there are provided balanced biasing loads on the corner seals by concentrically arranged multi-coil coil springs whose loads are not limited by the maintenance of a reasonable spring rate. This is accomplished by forming a concentric blind bore or hole **84** in the backside of each corner seal **60** which may extend about half the length thereof as shown in FIG. **3.** In addition, there is formed both a triangular shaped notch **86** with chamfers **88** on either side in the interface **74** of each end apex seal piece **70** and a triangular shaped notch **90** without chamfers in each interface **72** of the apex seal center piece **68.** The blind bore **84** in each corner seal **60** cooperates with the rectangularly shaped opening through the apex seal provided by the notch **86** in the apex seal end piece **70** and the notch **90** in the apex seal center piece **68** to provide an annular space **92** within the confines of hole **62** and about the end of the apex seal spring **76** concentric with the corner seal **60** and it is in this space that a coil spring **94** having a plurality of turns is mounted. With the multi-turn coil spring **94** which is so compactly arranged in concentric relationship with the corner seal, there is thus provided balanced loading on the corner seal and with a substantially greater amount of elastic travel within the stress limits of the spring's material as compared with the typical corner seal spring of stamped sheet metal or single loop wire. Thus the coil spring **94** can provide higher spring loads on the corner seal with reasonable spring rates as compared with the typical corner seal leaf or single loop wire spring arrangement.

The above described embodiment is illustrative of the invention which may be modified within the scope of the appended claims.

I claim:

1. In a rotary machine, a housing having an inwardly facing inner peripheral wall and a pair of spaced oppositely facing inner end walls, a rotor rotatably mounted in said housing having sides opposite said end walls and a plurality of corners that remain adjacent said peripheral wall as said rotor rotates, said rotor and said housing walls cooperatively defining a plurality of chambers separated by said rotor corners that expand and contract as said rotor rotates, each said rotor corner having an apex seal slot extending thereacross facing radially outwardly toward said peripheral wall, each said rotor side at each corner having a corner seal hole immediately joining with one of said apex seal slots and facing outwardly toward one of said end walls, each said rotor side further having a side seal groove extending along the periphery of said rotor side and joining at opposite ends with two of said corner seal holes, apex seal means mounted in each said apex seal slot and extending at opposite ends into the adjoining corner seal holes, a side seal mounted in each said side seal groove and extending at opposite ends into the adjoining corner seal holes and engaging the opposite end wall, a corner seal mounted in each said corner seal hole for engaging the opposite end wall, each said corner seal having a centerline and a periphery engaged by the ends of two adjoining side seals and also having an apex seal slot receiving the adjoining apex seal means whereby the corner seal provides a sealed juncture between the adjoining apex seal means and two side seals, a leaf spring having a center portion seated on the bottom of each apex seal slot in said rotor and having end portions extending into the adjoining corner seal holes to engage and urge the apex seal means radially outward

against said peripheral wall, each said corner seal having a relieved portion in the backside thereof, and each said apex seal means having a relieved portion cooperating with the relieved portion in the adjoining corner seal to provide an annular space about the adjoining spring end portion concentric with the corner seal and within the accommodating corner seal hole between the corner seal and the bottom of the accommodating corner seal hole, and a multi-coil coil spring mounted in each said annular space concentric with the adjoining corner seal for biasing the corner seal outward against the opposite end wall.

2. In a rotary machine, a housing having an inwardly facing inner peripheral wall and a pair of spaced oppositely facing inner end walls, a rotor rotatably mounted in said housing having sides opposite said end walls and a plurality of corners that remain adjacent said peripheral wall as said rotor rotates, said rotor and said housing walls cooperatively defining a plurality of chambers separated by said rotor corners that expand and contract as said rotor rotates, each said rotor corner having an apex seal slot extending thereacross facing radially outwardly toward said peripheral wall, each said rotor side at each corner having a cylindrical corner seal hole immediately joining with one of said apex seal slots and facing outwardly toward one of said end walls, each said rotor side further having a side seal groove extending along the periphery of said rotor side and joining at opposite ends with two of said corner seal holes, apex seal means mounted in each said apex seal slot and extending at opposite ends into the adjoining corner seal holes for engaging said peripheral wall, a side seal mounted in each said side seal groove and extending at opposite ends into the adjoining corner seal holes and engaging the opposite end wall, a cylindrical corner seal mounted in each said corner seal hole for engaging the opposite end wall, each said corner seal having a centerline and a periphery engaged by the ends of two adjoining side seals and also having an apex seal slot receiving the adjoining apex seal means whereby the corner seal provides a sealed juncture between the adjoining apex seal means and two side seals, a leaf spring having a center portion seated on the bottom of each apex seal slot in said rotor and having end portions extending into the adjoining corner seal holes to engage and urge said apex seal means radially outward against said peripheral wall, each said corner seal and adjoining apex seal means having recesses cooperatively providing an annular space about the adjoining spring end portion concentric with the corner seal and within the accommodating corner seal hole between the corner seal and the bottom of the accommodating corner seal hole, and a multi-coil coil spring mounted in each said annular space concentric with the adjoining corner seal for biasing the corner seal outward against the opposite end wall.

3. In a rotary machine, a housing having an inwardly facing inner peripheral wall and a pair of spaced oppositely facing inner end walls, a rotor rotatably mounted in said housing having sides opposite said end walls and a plurality of corners that remain adjacent said peripheral wall as said rotor rotates, said rotor and said housing walls cooperatively defining a plurality of chambers separated by said rotor corners that expand and contract as said rotor rotates, each said rotor corner having an apex seal slot extending thereacross facing radially outwardly toward said peripheral wall, each said rotor side at each corner having a cylindrical corner seal hole immediately joining with one of said apex seal slots and facing outwardly toward one of said end walls, each said rotor side further having a side seal groove extending along the periphery of said rotor side and joining at opposite ends with two of said corner seal holes, apex seal means including a center piece and two end pieces having inclined interfaces mounted in each said apex seal slot and extending at opposite ends into the adjoining corner seal holes, a side seal mounted in each said side seal groove and extending at opposite ends into the adjoining corner seal holes and engaging the opposite end wall, a cylindrical corner seal mounted in each said corner seal hole for engaging the opposite end wall, each said corner seal having a centerline and a periphery engaged by the ends of two adjoining side seals and also having an apex seal slot receiving the adjoining apex seal means whereby the corner seal provides a sealed juncture between the adjoining apex seal means and two side seals, a leaf spring having a center portion seated on the bottom of each apex seal slot in said rotor and having end portions extending into the adjoining corner seal holes to engage said apex seal end pieces whereby said inclined interfaces act to force the apex seal end pieces axially outwardly against the opposite end walls and also force the apex seal center piece radially outward against said peripheral wall, each said corner seal having a concentric blind bore in the backside thereof, and said interfaces of said apex seal pieces having triangular shaped notches cooperating with the blind bore in the adjoining corner seal to provide an annular space about the adjoining spring end portion concentric with the corner seal and within the accommodating corner seal hole between the corner seal and the bottom of the accommodating corner seal hole, and a multi-coil coil spring mounted in each said annular space concentric with the adjoining corner seal for biasing the corner seal outward against the opposite end wall.

* * * * *